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WATER RESOURCES DEVELOPMENT ACTION PLAN FOR NAGZIRA WILD LIFE SANCTURY, GONDIA DISTRICT, MAHARASHTRA USING REMOTE SENSING AND GIS

DHEERAJ KUMAR MISHRA[1], DEVENDRA PANDEY[2] & S. S. RATHORE[3]

[1]Associate Professor, Department of Civil Engineering, Manoharbhai Patel Institute of Engineering & Technology, Gondia, Maharashtra, India

[2]Professor, Department of Civil Engineering, Manoharbhai Patel Institute of Engineering & Technology, Gondia, Maharashtra, India

[3]Principal, Manoharbhai Patel Institute of Engineering & Technology, Gondia, Maharashtra, India

ABSTRACT

The present paper deals with water resource development action plan for Nagzira Wildlife Sanctuary watershed of Gondia district, Maharashtra using remote sensing and GIS techniques. The suitable site and check dams for watershed are suggested in consideration with physical parameters of the area to fulfill the increasing demand of water for wildlife. The study reveals that after the execution of the proposed plan, wild life can make most beneficial use of water of the proposed watershed to minimize Human Wildlife Conflict. The interpretation of remote sensing data in combination with auxiliary data and adequate ground information makes it likely to recognize and sketch various ground features such as geological, geomorphic, structural and hydraulic parameters that may act as direct indicators of water resource development action plan for Nagzira Wildlife Sanctuary watershed. Remote sensing data and GIS have emerged, to meet ever-increasing demand for more specific and timely information. These techniques consent rapid and gainful natural resource survey and management. Remotely sensed data is used for accruing factual information on geology, geomorphology, structural pattern and drainage system, which help to engender water resources development action plan of Nagzira Wildlife Sanctuary. The study reveals that average availability of water for the wildlife in the proposed reservoirs will be 208125 cubic meters for whole year.

KEYWORDS: Nagzira Wildlife Sanctuary (NWS), Human-Wildlife Conflict (HWC), Survey of India (SOI)

INTRODUCTION

Survival of living beings on earth essentially depends on water, nature's worthless bequest to mankind. Water resources are enormously inadequate but renewable exhibiting multiplicity in their quality and quantity. Many parts of our country experienced acute scarcity of water for dissimilar purposes and the difficulty of water crisis is likely to become more severe and serious and will continue well in to the 21st century (Biswas, 1991). As human population expands and natural habitats shrink, people and animals increasingly come into conflict over living space, food and water. The impacts of such conflicts are often huge. People lose their crops, livestock, property, and sometimes their lives. The animals, many of which are already threatened or endangered, are often killed in retaliation or sometimes to 'prevent' future conflicts. Human-wildlife conflict (HWC) is one of the main threats to the continued survival of many species, in different parts of the world, and is also a significant threat to local human populations. And, if solutions to conflicts are not adequate, local support for conservation also declines (Mishra, et.al. 2014).

The occurrences of water in Gondia District are due to rain only. The portion of rain which joins the surface storage is the main source of drinking water in the Nagzira Wildlife Sanctuary (NWS). News reports from different quarters suggest that the conflict between animals of various wildlife sanctuaries and villagers in the periphery has been found to escalate during summer. The root cause behind this rise in number of incidents of encroachment of wild animals of various reserve forests in the surrounding villages and agricultural fields is the acute shortage of water in the forest areas during summer. Watershed based management has been accepted as the most rational approach today, as it conserves the ecosystem, restores the environmental degradation, stabilizes and sustains the overall yield of an area and hence has been adopted for the current study to minimize HWC in the vicinity of NWS.

Remote sensing with its advantages of spatial, spectral and temporal availability of data covering large and inaccessible areas within short time has become a very handy tool in assessing, monitoring and conserving water resources. Satellite data provides quick and useful baseline information on the parameters like geology, geomorphology, land use/land cover, lineaments and other features controlling the occurrence and movement of groundwater (Saraf and Choudhuray, 1998, Singh et al, 1993). Thematic layers generated using remote sensing data like geology, geomorphology, land use/land cover, lineaments etc, can be integrated in a Geographic Information System framework and analyzed using a model developed with logical conditions to derive watershed potential zones (Rokde,et.al.2004).

OVERVIEW OF THE STUDY AREA

The Districts of Gondia and Bhandara are in the North-Eastern extreme of Maharashtra State lying between 20° 39’ and 21° 38’ North latitudes and 79° 27’ and 80° 42’ East longitudes on the world map covering an area of 9280 sq. km. The Gondia and Bhandara districts lie entirely within the Wainganga basin. Three major tributaries of Wainganga -the Bagh, the Bawanthari and the Chulband drain the districts. The major parts of Bhandara & Gondia districts are characterized by undulating topography with dense forest. The highest contour of 900 meters is situated in the South-East at Navegoan-Dogar hill and lowest contour value is 200 to 300 meters throughout South-East and North sector of the district. The slope is very steep in the East and North-West directions compared to the Northern, Southern, South-Western and Western part of the district. The central part of the district forms a valley which extends roughly Northeast-South, East-West direction (Pandey, et.al.2005).

DRAINAGE

The Wainganga and the Bagh are the main rivers, which drain along the valley and roughly divide the area into two parts. The Wainganga River flows at an average velocity of 10 km/hour, and is having an overall length of about 200 km. within the Gondia and Bhandara districts (Pandey & Jain, 2012). The Wainganga valley forms a central depression in the districts occupying one third of its area. The valley floor is formed over an Archaen crystalline terrain and is covered by riverine alluvium. The Bagh valley occupies the eastern part of the district. The Bagh River joins the Wainganga on its left bank as the later enters in the Gondia district. The Bagh River flows at an average velocity of 18 km/hour, and has an overall length of about 166 km. the valley floor is formed over grainitic terrain. The other periodical rivers that drain the area are the Sur, the Bawanthadi, the Maru, the Garvhi, and the Chulband. The average elevation of the district ranges between 150 m to 900 m above MSL (Pandey & Ali, 2013).

ENVIROMENTAL SCENARIO OF THE AREA

Nature is constantly in changing state, with or without the intervention of man, but industrial activities can hasten

these changes and cause them to go in unfavorable directions that result in environmental damages (Rathore & Pandey, 2002). That is why priorities need to be established. Whether or not, changes of natural state are to be tolerated depends on the priorities in economic development strategy. Scarcity arises from the fact that environmental assets, such as clean water and air have a limited capacity to absorb foreign material before they start changing their state. The change of state may be through destruction of water bodies due to excessive nutrients, which support plant life in water (Pandey, 1998, 2012, 2013). About 80% of the available groundwater is used for agricultural & industrial purposes, whereas 20% is used for potable water supply throughout the districts. There exist few groundwater-recharging sites in the districts at Bodalkasa, Chorakhmara, Nawegaon, Totladoh, Kalisarad, Kharwanda, Chulband etc. in the districts. Besides this the Wainganga and the Bagh rivers also contribute significantly for recharging ground water in the districts. There are 580 large and 13,758 small and medium sized tanks scattered all over the districts (District Gazetteer, 1979). These tanks are mainly distributed in the Wainganga, Bagh, Chulband and Garhvi valleys. The catchments area of these tanks ranges from 1 to 40 sq. km. These tanks act as recharging sources to the ground water in the districts (Pandey & Rathore, 2011). About 26.69% areas are under forest where as 55.71% of the total geographical area of the districts is cultivated area. The supply for potable water throughout the districts is by ground water sources except Gondia, Tirora, Tumsar and Bhandara towns where the stream water does it (Pandey, 1999).

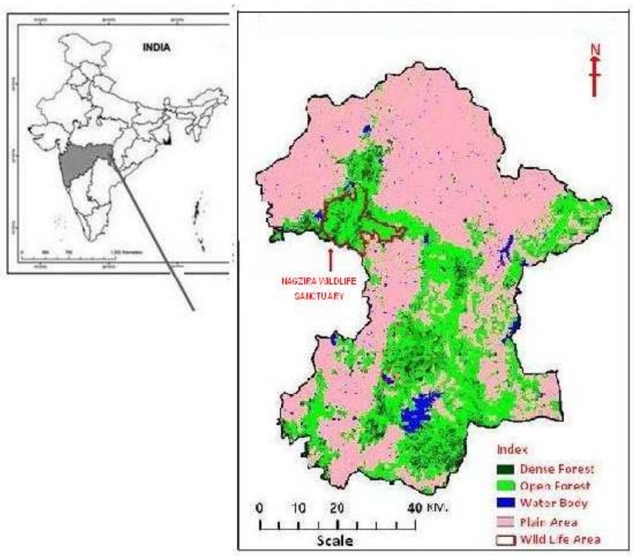

Figure 1: Showing Location Map of Nagzira Wildlife Sanctuary

METHODOLOGY

The main objectives of the study are to collect subsidiary data and generate different thematic maps from satellite data and to prepare implementable water resources development action plan on 1:50,000 scales supported by various thematic maps like – Base, Drainage, Geological, Geomorphological and Land use/Land cover map. The suitable site selection and building structures for watershed are suggested in consideration with physical parameters of the area to fulfill the ever increasing demands of water for drinking purposes of wild life. The study revealed that after the execution of the proposed plan, wild life can make most beneficial use of water of the proposed watershed to minimize HWC.

O'Brien has prescribed the adaptive capacity index for selecting watershed and its future vulnerability impact to climate change across districts (O'Brien et al 2004). Even TERI has also prescribed socioeconomic and technological

factors, indicators of adaptive capacity (TERI, 2006). However, for the proposed watershed these norms are not applicable.

CASE STUDY

The total area of the NWS is 152.58 sq. km. which is divided into one Range, four Rounds, eighteen Beats and thirty-seven compartments. The study area falls under “Nagzira Sankul” Round, which is further sub-divided in to three beats, i.e. Nagzira-I, Nagzira-II and Nagzira-IV. The total area falling under study area is 3.04 sq. km. In the present study, topographical maps prepared by Survey of India on 1:50,000 scale, IRS-1C LISS III digital data (Path 100 and Row 57) dated 11th March 2000 were used. Secondary data on hydrology, type of aquifers and depth of weathering were collected from Groundwater Survey and Development Agency, Gondia as well as during the field visits. Survey of India Toposheet No. 64 C/3, 64 C/4, 55 O/15, and 55 O/16 on 1:50,000 scales were also used. The proposed watershed falls under Toposheet No. 64 C/4. Geological map published by Geological Survey of India on 1: 250,000 scales were also used. The IRS- 1C LISS III and PAN data were registered to SOI topographical map No. 64 C/4 on 1: 50, 000 scales in GRAM^{++} image processing software were used. The satellite imagery for better interpretation of the geological, geomorphological, and structural and land use/ land cover information was also used as shown in Figure 2. GIS modeling was done to demarcate the zones of suitable watershed building structures. Discussions were held with NWS employees and their suggestions are incorporated to finalize the proposed water resources developmental action plan.

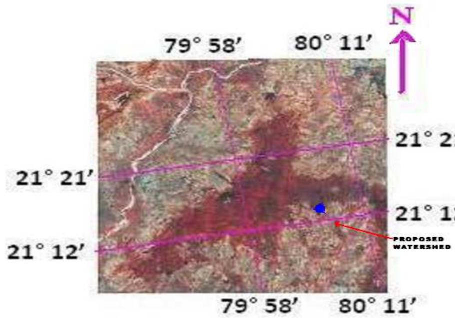

Figure 2: Showing IRS-1C LISS III FCC Image of NWS

Geology & Lineament of the Area

Lineaments mapped from satellite data are natural straight lines or curvilinear features that can be correlated to fault, fractures, joints, lithological contacts, etc. The study area is characterized by major NW-SE trending lineaments. The dominant trend of the lineaments is NW-SE. Archean Grainitic Gneisses are characterized by NW-SE, Archean show minor undulations and various faults with NW-SE strike directions. The surface evidences of these faults are not observed within proposed watershed area of NWS as shown in Figure 3.

Geomorphological expressions exert tremendous control on the watershed. The relief, slope, depth of weathered material, types of the weathered material and the overall assemblage of different landforms play an important role in defining the watershed management more particularly in hard rock areas. On the basis of interpretation of satellite image, Toposheet of SOI and field visits it is clear that geomorphology of the area covers 3.04 Sq.km, comprises of plateau, piedmont gentle slope, pediment and flood plain of non perennial local drain. The geomorphology of the area is as shown in Figure 2.

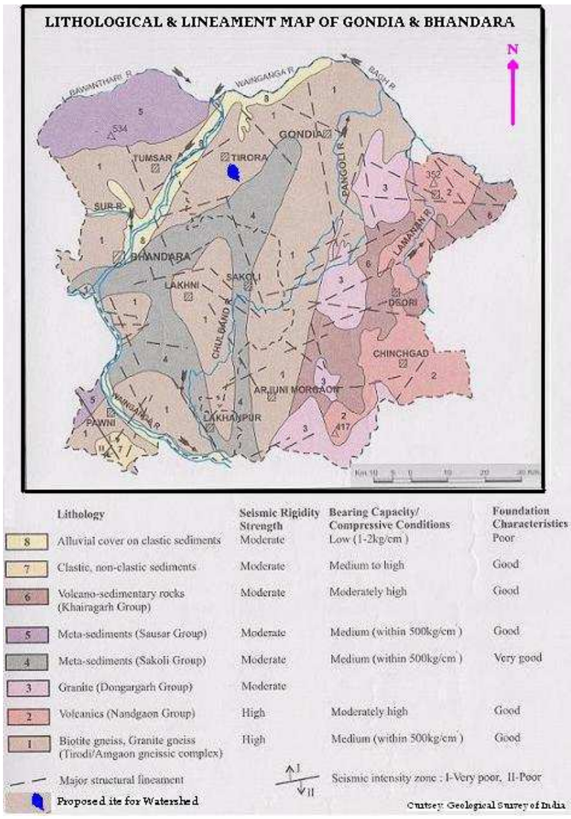

Figure 3: Shows Lithology & Lineament of the Proposed Watershed Area

Land Use/Land Cover

Land use describes how a parcel of land is used for different purposes such as agriculture, settlements or industry, whereas land cover refers to the material such as vegetation, rocks or water bodies that are present on the earth surface (Anderson et al, 1976). Information on land use and land cover is necessary for assessment of watershed management. About 100 % area of the watershed falls under NWS. The thick deciduous forest is restricted to plateau side drainage and occupies complete area. Area covered by small drainages, Bodalkasa, Chorakhmara tanks and other small ponds is only 1.5 % and 0.5 % area is occupied by built-up land area such as covered by villages and forest administrative offices and residential buildings of employees of NWS as shown in Figure 2.

Water Resources Development Plan and Its Implementation

The development of water resources is needed to meet the water requirements of wildlife of NWS. The water resources development plans of the area have been prepared on the basis of geology, geomorphology, drainage, surface water bodies and present land use/land cover in the area. This plan prepared for the area clearly depicts the check dams. Check dams are constructed across small streams having 8 to10 meters of gentle slope and are feasible both in Granite rock as well as in lateritic soil in the foundation. Check dams are constructed to serve as storage reservoir for wildlife purpose. The area suitable for check dams is underlined by formation of Amgaon Granite with shallow and deep pediplain. The land use/land cover is of forest and open area. The railway track of Gondia-Chandrapur broad gauge line runs parallel in the Eastern boundary of NWS, which runs north-east to south-east direction of proposed watershed. In the south-west of the proposed watershed the village Malijunga is situated at about 800 meters and eastern side the village Rengepar is located at about 500 meters. Figure 3: shows of different litho-units in the area.

The watershed is bound by Latitudes 21^0 13’ 30’’ N & 21^0 15’ N and Longitudes 80^0 7’ E & 80^0 8’ E. The total area under the proposed watershed is 3.04 sq. km. The general trend of slope is towards SE direction. The highest elevation value is 298 MSL and is situated in the North and the lowest elevation value is 280 MSL and is situated in SE quadrant as shown in Figure 4. The proposed watershed area is divided into two numbers of Check dams in the present research work as shown in Figure 4, namely as the lower watershed and the upper watershed. The lower watershed comprises of an area of 0.5 sq. km. which includes following portions F, G, H, I & 6. The upper watershed comprises of an area of 0.75 sq. km. which includes following portions C, M, 3 & 4 as shown in the Figure 4.

With reference to the average 20 years of rainfall in the study domain area as 1200 mm, for a height of 1 meter of the proposed lower check dam, the total volume of runoff water stored in the reservoir will be 250000 cubic meter. Similarly, in case of the upper check dam of height 1 meter, the total volume of water stored in the reservoir will be 375000 cubic meters. Total projected volume of water stored in both the reservoirs will be 625000 cubic meter at the end of monsoon season. The loss of water from reservoirs due to evaporation and percolation will be 66.6% of total volume. The average available water for the wildlife in the proposed reservoirs will be 208125 cubic meters throughout the year.

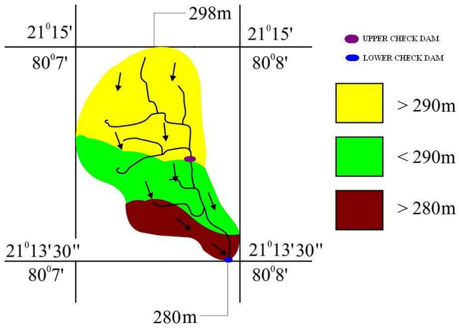

Figure 4: Shows Slope Map of Proposed Watershed Area

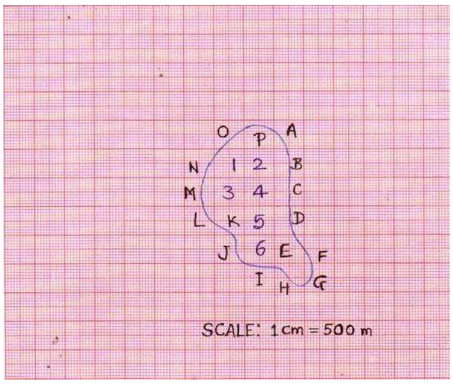

Figure 5: Showing Area of Covered of Proposed Watershed

Area Calculation of Watershed

A=15%, B=50%, C=50%, D=55%, E=90%, F=05%, G=10%, H=50%, I=05%, J=25%, K=90%, L=10%, M=40%, N=15%, O=30%, P=75%

TOTAL FRACTIONAL AREA = 615 % = 6.15 cm^2

TOTAL MAP AREA = 6.00 + 6.15 = 12.15 cm^2

TOTAL ACTUAL AREA = 12.15 x 0.5 x 0.5 = 3.04 km^2

CONCLUSIONS

This study has demonstrated the cost and time effective use of integrated remote sensing and GIS based techniques for creation of water resource developmental action plan. NWS watershed study domain is divided into two numbers of watershed potential zones. The average availability of water for the wildlife in the proposed reservoirs will be 208125 cubic meters. The location of the proposed watershed will help in reducing the movement of wildlife across the railway track thereby minimizing the rail accidents. This would fulfill the prime objective of the work to minimize HWC in the vicinity of NWS.

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